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(56) Documents cited
GB 1353021 A GB 1223082 A GB 1113209 A
GB 1097812 A GB 0450941 A

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(54) Flame effect simulator

(57) A flame effect simulator for a domestic fire has at least one roller 10 with an irregular reflective surface 14. A light source 7 is arranged to direct light onto a selected portion 17 of the surface and light is reflected onto a translucent screen 3. The roller is rotated thereby continuously varying the visual effect displayed on the screen. The light source is located in a lower compartment 5 beneath a dividing wall 6 defining at least one slot 8 through which the light is projected. The dimensions of the apparatus are selected such that the images comprising the visual effect comprise catacaustic fine detail which is suggestive of filaments of flame.

FIG. 1.

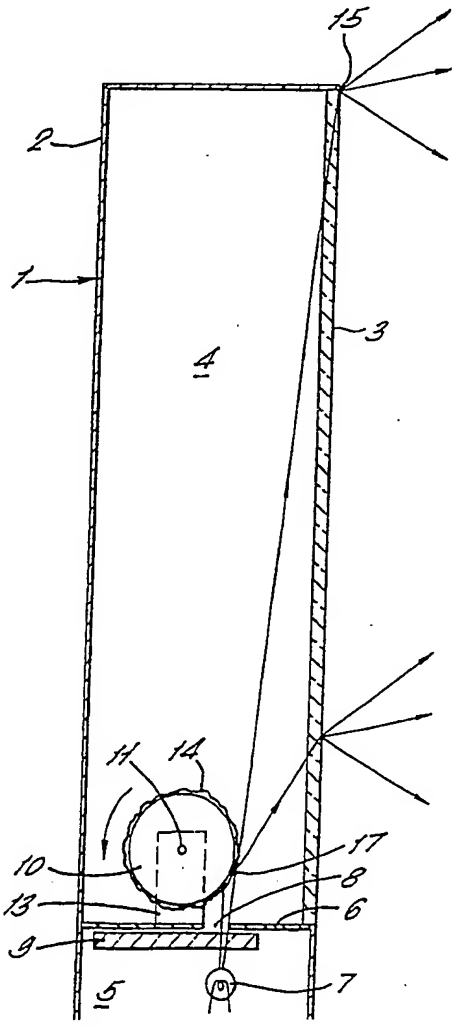

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FIG. 1.

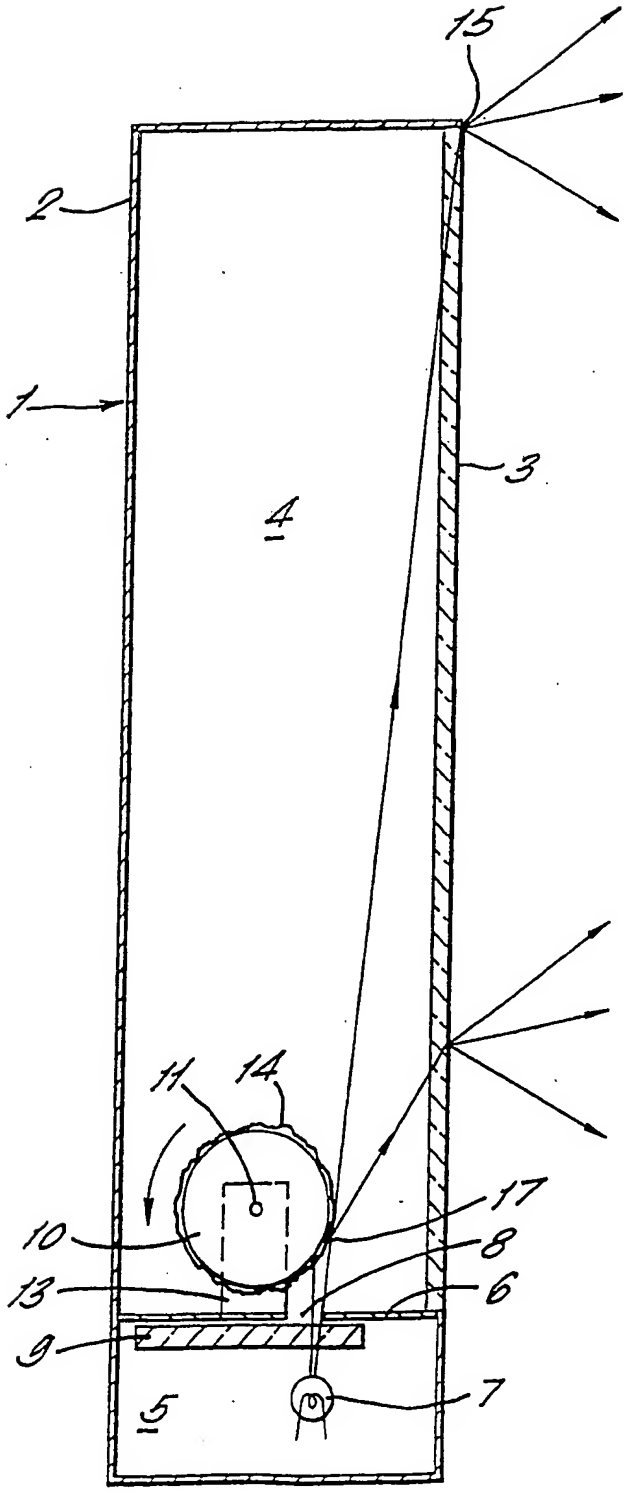


FIG. 2.

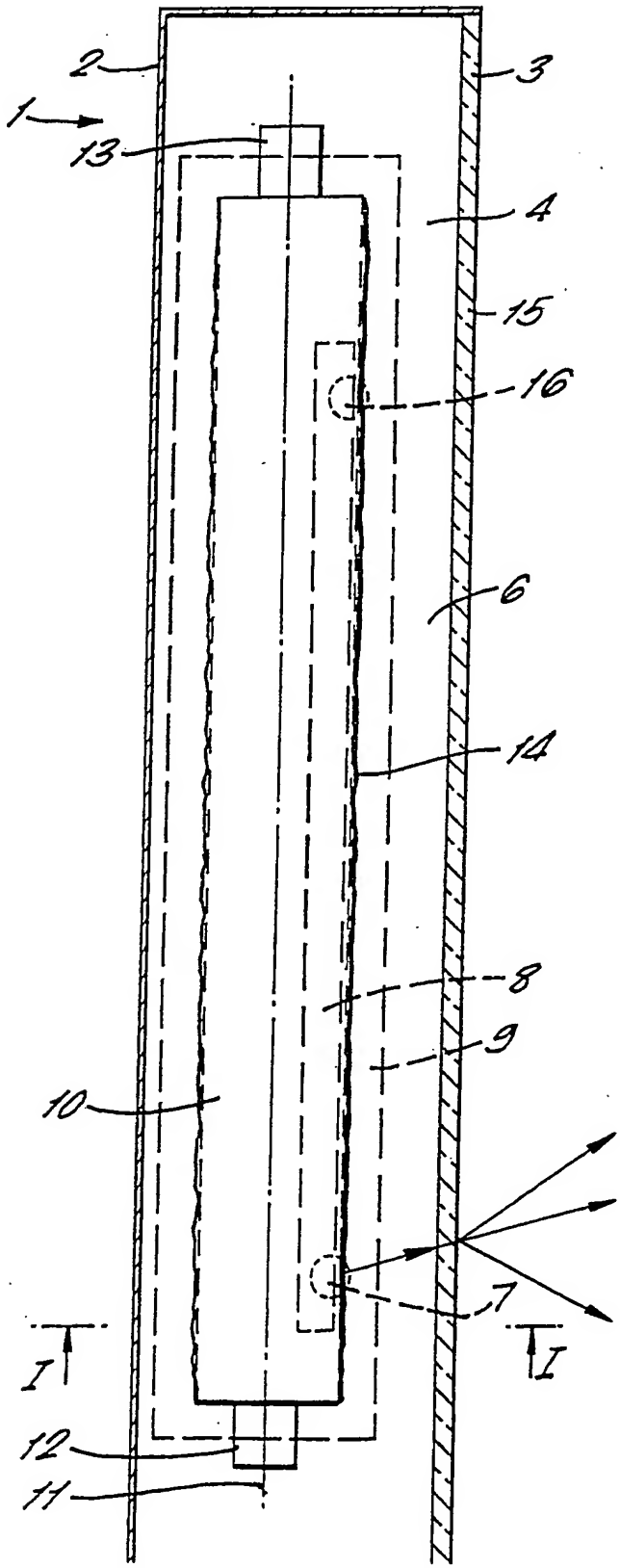


FIG. 3.

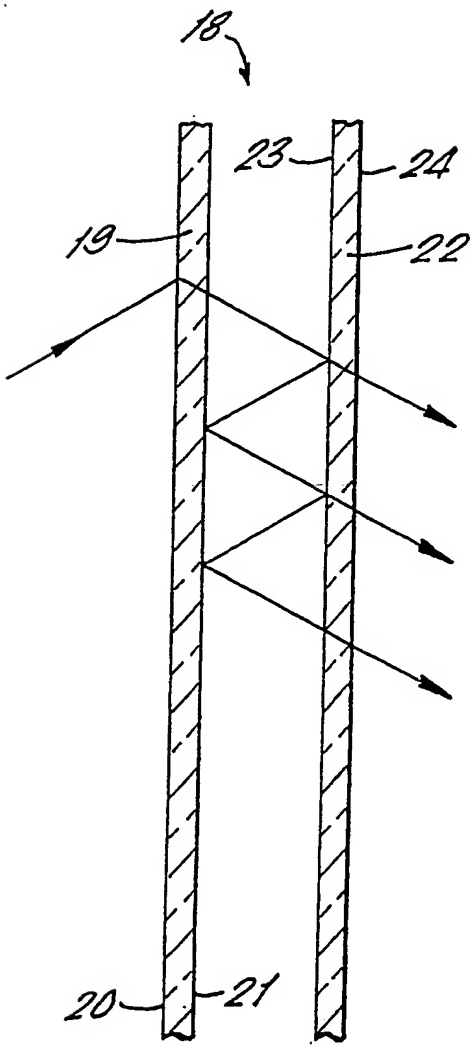


FIG. 4.

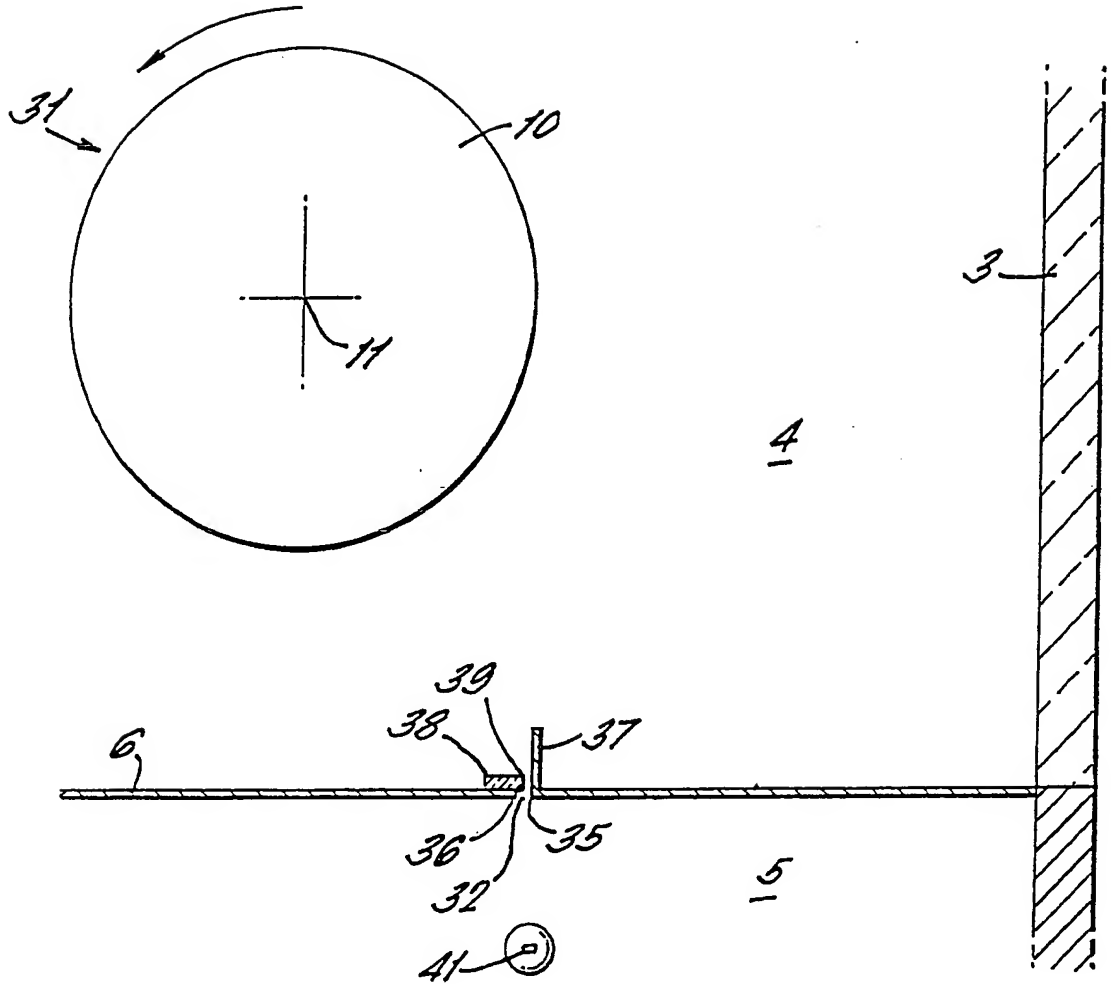


FIG. 5.

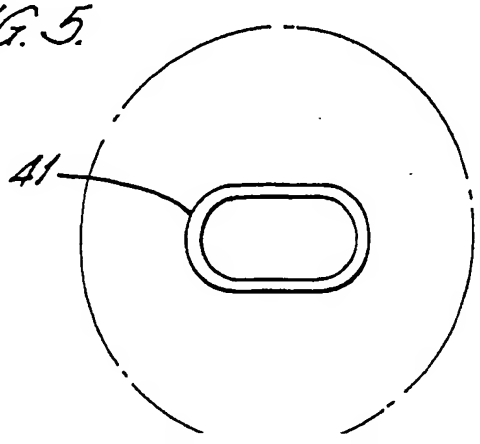


FIG. 6.

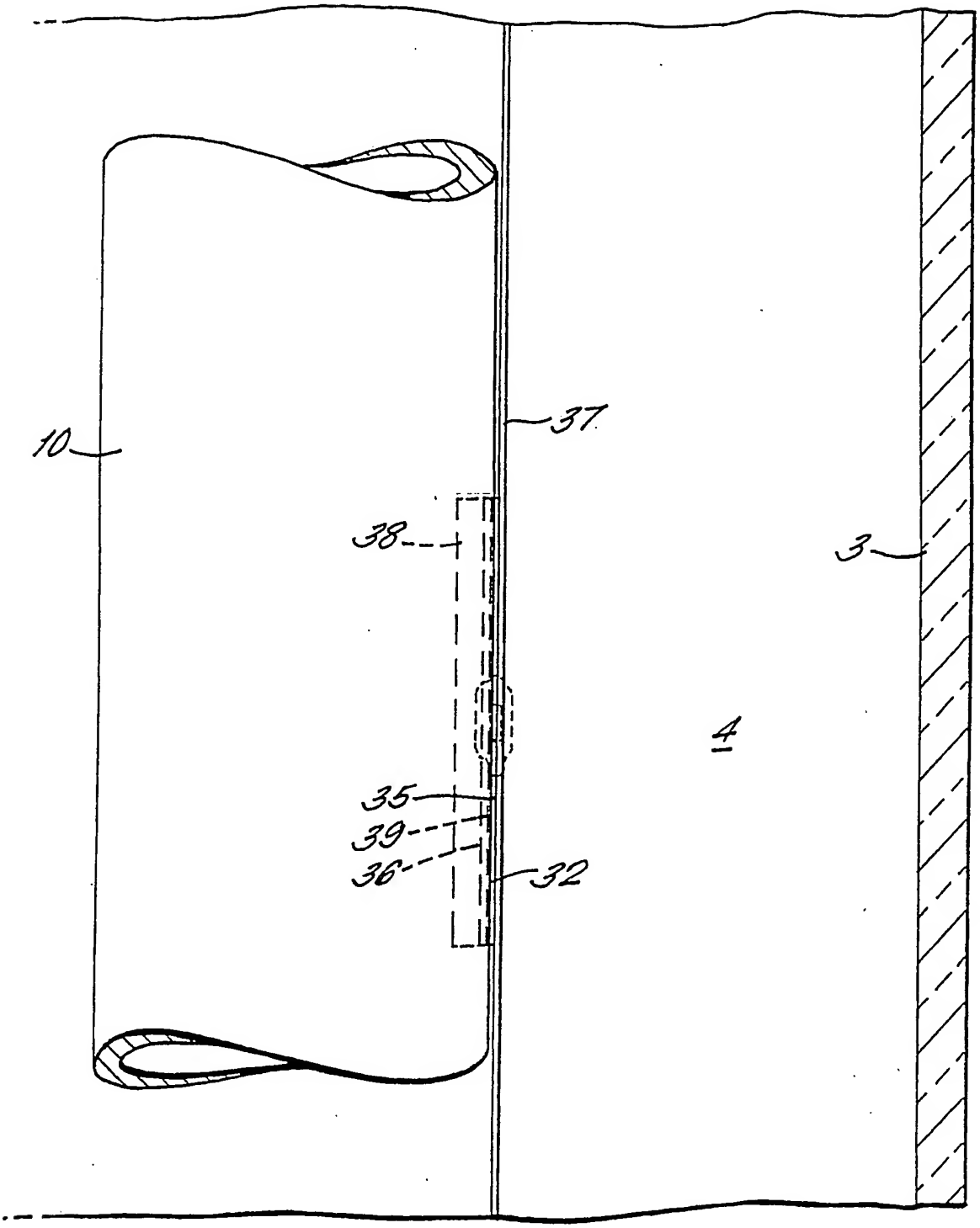
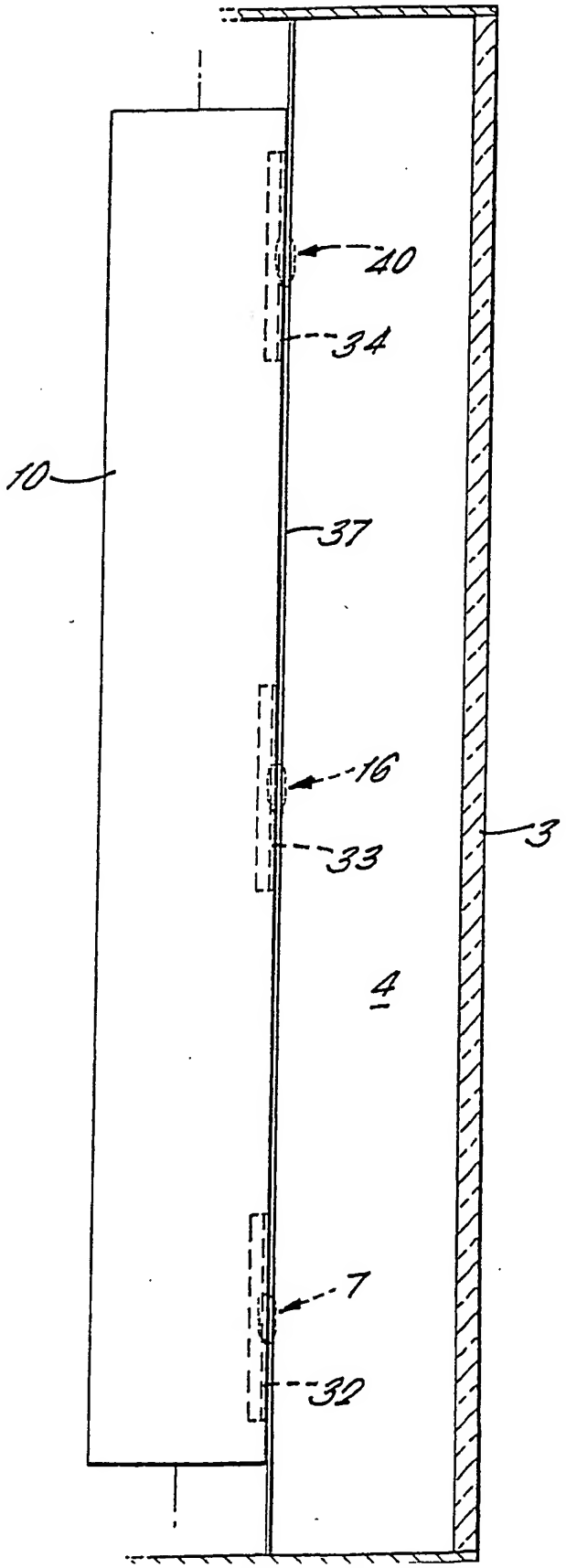


FIG. 7.



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"FLAME EFFECT SIMULATOR"

This invention relates to apparatus for simulating the visual effect of flames and in particular but not exclusively to a flame simulator of a domestic heating appliance.

It is proposed in GB-2236845A to provide a flame effect simulator in which collimated light is deflected by refraction or reflection at an irregular surface and the deflected light is projected on to a screen to provide the visual effect of flames. Movement of the flame effect is provided by transverse motion of the deflecting element relative to the collimated light, this movement being provided by means of a rotating disc arrangement.

The resulting flame effect includes fine detail which is a particularly realistic emulation of flame filaments.

Whilst producing satisfactory results such a simulator has the disadvantage of typically requiring a laser to provide an adequate source of collimated light. This is both expensive and limits the available effect to a single colour unless multiple lasers are used.

It has also been proposed in GB-1097812 to use a lamp of the incandescent filament type in a flame effect simulator in which light from such a lamp is reflected on to a screen from an irregular reflective surface formed on a rotating cylindrical roller. The screen is thereby illuminated non-uniformly with patches of light which move upwardly of the screen.

A disadvantage of such a simulator is that although the moving patches of light may create an interesting visual pattern they do not emulate the fine structure of filaments of flame typically present

in a coal or log fire. It is estimated that for the example illustrated in GB-1097812 using a conventional tungsten filament light bulb the minimum size of each patch of light would occupy approximately one quarter of the screen area.

It is an object of the present invention to provide a realistic flame effect having fine detail of the type provided by GB-2236845A but without recourse to the use of lasers.

According to the present invention there is disclosed apparatus for simulating the visual effect of flames comprising a roller having an irregular reflective surface, a light source arranged to direct light on to a selected portion of the reflective surface such that the light source subtends an angular size W as viewed from the reflective surface, movement means operable to rotate the roller so as to continuously vary the selected portion of the reflective surface on to which light is directed, and a display screen on to which partially formed images of the source are projected from the selected portion of the reflective surface whereby a continuously variable visual effect is displayed on the screen, the visual effect comprising images formed on to respective portions of the screen at respective projection distances V from the reflective surface and wherein the values of W and V are such that, for at least a substantial proportion of the portions of the screen, respective images formed thereon comprise catacaustic fine detail which in the visual effect is suggestive of filaments of flame.

The term catacaustic is used in the sense of being the epithet of a curved surface formed by the ultimate intersection of luminous rays proceeding from a single point and reflected from a curved surface.

Formation of catacaustic fine detail can be visualised in terms of optical wave fronts as corresponding to folds or cusps in the evolution of an initially smooth wave front which undergoes some degree of distortion as in the case of reflection from an irregular surface. Typically a concavity formed in an irregular reflective surface can be approximated to a cylindrical reflecting surface which focuses in one dimension only to produce a catacaustic appearing as a bright line on the screen.

Each structure of catacaustic fine detail appearing on the screen is essentially a partially formed image of the light source from which the initially smooth wave front originates, in the present apparatus the source being an incandescent filament. The structure size will therefore be determined by the apparent size of the source as viewed from the reflected surface and the degree of magnification provided by the dimensions of the apparatus.

Preferably the value of W in radians is selected such that images are produced for which the value of W x V lies in the range 0.001 to 0.005 metres.

Such an arrangement creates structures of catacaustic fine detail typically having a width approximately equal to the value of W x V and therefore lying in the range 1 to 5 mm. Typically the projection distance V varies according to which part of the screen receives the image. Preferably the structures having fine detail within the above range are concentrated in a lower part of the screen close to the roller such that intense structures having fine detail are produced whereas towards the top of the screen structures with less intensity and greater width are produced. Such an arrangement contributes to the illusion of there being flames at the lower

part of the screen and more diffuse flames and smoke rising to the top of the screen.

Preferably the width of the screen upon which images are formed satisfies the relationship

$$d > W \times V_{min} \times 50$$

where V_{min} is the minimum projection distance between the reflective surface and the screen.

Typically, the roller will be located close to the bottom of the screen so that V_{min} approximates to the horizontal distance between the screen and the circumference of the roller.

The above relationship between the width of the screen and the product W x V means that the screen width is more than 50 times the width of a typical structure of fine detail in the visual effect.

It is preferable to relate the size of the catacaustic fine detail structures to the size of the screen such that a large number of structures can be simultaneously projected on to the screen without reaching a saturation level beyond which the addition of further structures will impair contrast between bright structures and background. The number of structures appearing on the screen at any given time is determined by the number of concavities of suitable radius on the reflecting surface and typically the number of concavities is arranged such that about fifty structures at a given horizontal level are visible at any given time. This number of structures can readily be accommodated without reaching saturation provided the above relationship is satisfied.

In preferred embodiments of the present invention the reflective surface comprises a crumpled layer of reflective foil wrapped around the roller.

Preferably the roller is mounted in an enclosure

of which the display screen constitutes a front wall, the enclosure having a dividing wall which divides the enclosure into an upper compartment containing the roller and a lower compartment containing the light source, the dividing wall defining a slot through which light is directed on to the selected portion of the reflective surface and wherein the relative positions of the slot, the light source and the roller are such that direct illumination of the screen from the light source is masked by the dividing wall.

The dimensions of the slot thereby determine the size of the selected portion of the reflective surface. By illuminating the reflective surface only via this slot it is also possible to almost totally exclude stray light from reaching the screen. A further important function of the slot arrangement is that, by using a narrow slot in conjunction with a compact light source, it is possible to obtain illumination of the selected portion of the reflective surface by a narrow beam of light which can be characterised in terms of smooth wave fronts which are essentially unperturbed. When these wave fronts are reflected from the reflecting surface the conditions are then optimum for producing cusps and folds in the reflected wave front which can then be viewed as catacaustic sharp lines provided a light scattering surface is placed in the path of the reflected light at a point at which the partially formed image is focussed. The partially formed image in this instance is that of the light source itself which in the case of an incandescent filament will be an image of the filament which is distorted according to the shape of the reflecting surface.

For such catacaustic fine detail to be produced it is therefore essential that a compact and highly

localised light source be used.

The flame effect produced by the apparatus of the present invention is strikingly realistic in the way in which the shape of real flames is suggested by the image structures produced on the screen for reasons which may be understood by considering the way in which certain flames produce light. In such flames hot gas mixes with combustible air and a reaction occurs in which the gas is oxidised in a very thin zone. This zone can be thought of as a thin membrane which rapidly changes location and topology. The light produced from the thin membrane can be regarded as emanating from a changing two dimensional surface where the reaction occurs.

When an observer looks at such a flame he sees what in effect is a mapping of the two dimensional luminous source on to the retina where a two dimensional image is created. This mapping process will make apparent edges of the flame formed by areas of the membrane extending parallel to the observer's line of sight appear much brighter than the remainder of the flame.

The optical arrangement provided by the apparatus of the present invention achieves an analogous result. Because the source is point-like, the two dimensional reflective surface of the roller is mapped on to the two dimensional surface of the screen. This mapping process similarly produces singularities or edges which in the image structures on the screen are viewed as sharp lines of fine detail against a background of lower intensity. These singularities appear as folds and cusps, the folds being viewed as sharp lines connected by cusps. This phenomenon, referred to in terms of the production of catacaustics, can be seen as being directly analogous

to the formation of structures when such flames are observed.

Hence the flame effect produced in accordance with the present invention is particularly realistic.

Preferably a coloured filter is located intermediate the light source and the reflective element.

Conveniently the filter is located immediately adjacent the slot.

The roller may be horizontally mounted adjacent a bottom edge of the screen, the light source being located such that its vertical position is below the rotational axis of the roller and its horizontal position is intermediate the rotational axis and the screen, and the direction of rotation of the roller being such that the selected portion upon which light is directed is upwardly moving.

Advantageously the filter overlays a portion of the slot such that images formed in lower regions of the screen are predominantly constituted by filtered light which is reflected from the reflecting surface after passing through the filter and images formed in upper regions of the screen are predominantly constituted by unfiltered light.

The light source may then advantageously be a white light source and the filter can be a clear red transparency in order to produce predominantly red visual effects at the base of the screen which become progressively white light effects towards the other part of the screen. Because of the nature of the irregular reflecting surface there is no clear demarcation on the screen between filtered and unfiltered light provided that the filter is located intermediate the source and the reflecting surface. It is however important that the filter should be

essentially clear in the sense of being non-scattering. The effect of scattering would be detrimental since it would have the effect of extending the apparent size of the source.

Preferably the source comprises an incandescent filament.

Preferably care should be taken in the orientation of the filament relative to the slot, roller and screen since it is partially formed images of the filament which appear on the screen in the visual effect. In a preferred embodiment of the invention the filament extends helically about a linear axis extending parallel to the roller. Satisfactory results could also be obtained using a larger filament which was oriented to have its axis at right angles to the roller if in that orientation the apparent size of the filament remained the same.

In a typical arrangement the value of W is determined by the dimensions of the filament as viewed from the reflective surface. W then approximates to the linear dimension of the filament as viewed in projection divided by the linear separation between the filament and the reflecting surface.

The apparent size of the source may alternatively be limited by the intervention of a mask having a source-limiting aperture of smaller dimensions in the filament when viewed from the reflecting surface, the mask being located in proximity with the source to determine the value of W.

In a preferred embodiment the light source comprises a tungsten halogen lamp.

Conveniently a plurality of light sources may be provided at locations spaced apart longitudinally with respect to the roller to provide visual effects on respective areas of the screen.

Each light source may then be provided with an individual slot and filter of the type referred to above. The light sources may be placed sufficiently close together such that the visual effects overlap to some extent although care must be taken to avoid reaching saturation of the screen.

The display screen may comprise a first translucent plate through which the visual effect is viewable by diffuse transmission of light from the reflective element.

The extent to which light is diffused by the plate is preferably sufficient to prevent objects behind the plate such as the roller from being discernable to the observer.

Preferably the first translucent plate comprises a light scattering surface upon which light from the reflective surface is incident and a second surface which is partially reflecting, the screen further comprising a second transparent plate having at least one partially reflecting surface maintained in parallel spaced relationship relative to the first plate whereby multiple images of visual effect are created by multiple reflections between the partially reflecting surfaces.

An advantage of such an arrangement is that it creates the illusion that the simulated flames are three-dimensional. The presence of the light scattering surface is essential to the formation of the visual effect since it enables the catacaustic images to be viewed. In the absence of a scattering surface, for example in the presence of a purely reflecting screen, the catacaustic features would not be perceived as such but rather as twinkling points of light.

The apparatus may include at least one further

roller having a respective further reflective surface and being located intermediate the roller and the display screen whereby some of the light reflected from the reflective surface of the roller is projected on to the display screen indirectly by reflection from the further roller or rollers.

More complex visual effects are thereby achieved to add interest to the flame simulation viewed by an observer.

Preferably the roller is located adjacent one edge of the screen and is uniformly rotated in a direction selected such that an image formed at an initial position on the screen by reflection from the reflective element is moved progressively towards a new position on the screen which is at a greater distance from the reflective element than the initial position.

An advantage of such an arrangement is that the images focussed on the screen are made to accelerate across the screen thereby emulating the behaviour of real flames.

Preferably the roller is mounted in an enclosure of which the display screen constitutes a front wall, the enclosure having a dividing wall which divides the enclosure into an upper compartment containing the roller and a lower compartment containing the light source, the dividing wall defining a slot facilitating indirect illumination of the screen by reflection from the reflecting surface of the roller and the relative position of the slot, the light source and the roller being such that direct illumination of the screen is masked by the dividing wall.

An advantage of such an arrangement is that light emerging from the screen is substantially limited to that which is reflected from the reflective

element so that maximum contrast is provided between the visual effect and the enclosure.

Preferably the roller is horizontally mounted adjacent a bottom edge of the screen, the light source being located such that its vertical position is below the cylindrical axis of the roller and its horizontal position is intermediate the cylindrical axis and the screen, and the direction of rotation of the roller being such that the illuminated portion is upwardly moving.

Embodiments of the present invention will now be described by way of example only and with reference to the accompanying drawings of which:-

Figure 1 is a schematic side elevation of apparatus in accordance with the present invention;

Figure 2 is a schematic plan view of the apparatus of Figure 1;

Figure 3 is a schematic side elevation of an alternative display screen for use with the apparatus of Figures 1 and 2;

Figure 4 is a schematic side elevation of a modified apparatus;

Figure 5 is an enlarged side elevation of the light emitting element of the apparatus of Figure 4;

Figure 6 is a plan view of part of the apparatus of Figures 4 and 5; and

Figure 7 is a schematic plan view showing the general layout of the apparatus of Figures 4, 5 and 6.

In Figure 1 an apparatus 1 comprises a rectangular walled enclosure 2 of which a front wall comprises a translucent screen 3, the remainder of the enclosure 2 being opaque and internally coated with a matt black light absorbing finish.

The translucent screen 3 extends vertically to a height of 0.4 metres and is 0.35 metres in width.

The screen 3 is a glass screen of opalescent appearance so as to scatter any light which is transmitted through the screen.

The enclosure 2 defines an upper compartment 4 which is divided from a lower compartment 5 by a horizontal dividing wall 6. A first light source 7 is located in the lower compartment 5 at a location which is generally beneath a slot 8 provided in the dividing wall 6 and extending transversely of the enclosure 2. A coloured filter 9 is located intermediate the first light source 7 and the slot 8.

A cylindrical roller 10 is mounted in the upper compartment 4 and defines a cylindrical axis 11 extending transversely of the enclosure 2 at a location which is generally above the slot 8. The roller 10 is journalled in end supports 12 and 13 incorporating an electrical motor drive for rotating the roller in a direction which appears anti-clockwise when viewed transversely as in Figure 1.

The roller 10 is provided with a reflective surface 14 which is generally cylindrical but of irregular finish. The reflective surface 14 is provided by a crumpled layer of aluminium foil wrapped around the roller 10. The roller 10 is mounted at a location which is adjacent the dividing wall 6 so as to be at the lower end of the upper compartment 4. The slot 8 is substantially narrower in width than the radius of the roller 10 and is located so as to extend parallel to the cylindrical axis 11 and intermediate the cylindrical axis 11 and the screen 3 when viewed from above as in Figure 2. The horizontal displacement of the slot 8 from the cylindrical axis 11 is slightly less than the radius of the roller 10, the location of the slot being selected such that a line drawn between the upper edge 15 of the screen 3

and tangentially touching the roller 10 will just pass through the slot 8. The first light source 7 is located beneath the slot 8 at a position such that direct illumination of the screen 3 is prevented by the masking effect of the dividing wall 6 but substantially the whole vertical extent of the screen 3 is accessible to light reflected from the surface 14 of the roller 10. It should be noted that in the schematic drawings of Figures 1 to 3 the features of the apparatus and in particular the light source 7 are not drawn to scale and in practice a bulb having minimal physical dimensions is used to approximate as far as possible a point source.

As shown in Figure 2 the apparatus 1 is provided with a second light source 16, the first and second light sources 7 and 16 being located adjacent to opposite ends of the roller 10. Each of the first and second light sources 7 and 16 is provided by a tungsten halogen light bulb of 40 watts power consumption. The bulbs are powered at less than their maximum operating rating in order to extend bulb life. The disposition of the second light source 16 and the screen, roller and slot 8 when viewed laterally as in Figure 1 corresponds to that of the first light source 7.

Light from the light sources 7 and 16 passing through the slot 8 will illuminate a portion 17 of the reflective surface 14 extending longitudinally of the roller and which is slightly wider than the aperture defined by slot 8. The portion 17 will be much greater in circumferential extent than the dimensions of the slot because the illumination is, in part, almost tangential with respect to the roller. Some of the light incident on the surface portion 17 will be reflected on to the screen 3 such that an irregular

pattern of light is formed by the scattered light transmitted through the screen. It has been found that a satisfactory pattern is formed provided that surface irregularities on the reflective surface 14 are capable of focusing light on to the screen. The focusing of light is associated with concavities in the surface 14 having a radius of curvature in at least one dimension which is approximately equal to the distance V travelled by the light before being incident on the screen. To ensure that the pattern extends over the whole area of the screen this requires that the irregularities in the surface include concavities of various sizes. In practice this is not difficult to achieve using crumpled foil provided that the crumples are large enough and sufficiently frequent.

The filter 9 is coloured in the vicinity of the slot 8 in a manner which varies so as to transmit light which is progressively blended from white, amber to red in a direction towards the screen 3 such that light transmitted through the red portion of the filter is predominantly reflected on to the lower portion of the screen and light transmitted through the white portion of the filter is reflected predominantly on to the upper portion of the screen.

In use the roller 10 is rotated at about one revolution per minute in a direction such that the surface portion 17 is moved upwardly. Light from the first and second light sources 7 and 16 passes through the filter 9 and through the slot 8 to be incident on the selected portion 17 of the reflective surface 14.

Light is reflected from the reflective surface 14 on to the screen 3 where flame-like striations of irregular pattern are focused. These striations are visible to an observer by virtue of that light which

is forward scattered by the screen.

The pattern of striations is continuously varied during each revolution of the roller as a result of the continued rotation of the roller 10 which results in an apparent upward motion of each individual striation accompanied by a progressive change in colour from red to white. Since the focusing effect of each concavity of the surface 14 is dependent on the distance V travelled by light from the surface to the screen it follows that individual striations will tend to progressively blur out of focus as a result of this movement and be replaced by others as they move upwardly to positions on the screen corresponding to a greater distance from the roller surface 14.

The random nature of the surface 14 also results in there being a non-uniform transition between red, amber and white coloured areas on the screen thereby contributing to the flame-like effect of the striations. Red images may for example appear in normally white areas and vice versa.

As each striation moves upwardly above the level of the roller 10 it appears to accelerate in upward movement. This effect arises because of the geometry of the light source 7, the roller 10 and screen 3 since, as the striation moves progressively upwardly its distance from the reflective surface 14 increases and this tends to amplify the effect of motion provided by rotation of the roller 10.

Figure 3 shows an alternative screen 18 having a first glass plate 19 defining a front wall to the enclosure 2. The first glass plate 19 has a light scattering surface 20 upon which light from the reflective surface 14 is incident and a smooth partially reflecting surface 21 through which scattered light emerges from the plate. A second

glass plate 22 is located in the path of the emergent light, being maintained in parallel spaced relationship relative to the first glass plate 19 and comprises surfaces 23 and 24 of which surface 23 is partially reflecting.

Multiple reflections between the partially reflecting surfaces 21 and 23 provide further visual effects in that the repeated striations create the illusion of a finite depth thereby contributing to the realistic simulation of flames.

An alternative apparatus 31 will now be described with reference to Figures 4, 5, 6 and 7 in which corresponding reference numerals to those of preceding Figures are used where appropriate for corresponding elements.

The apparatus 31 has a cylindrical roller 10 of 33mm diameter extending parallel to a translucent screen 3 such that the minimum distance separating the roller surface 14 and the screen 3 is 35.5mm.

The roller 10 is rotated at a rate of 11 rpm by a motor and gear box (not shown). A horizontally extending dividing wall 6 is located 16mm below the circumference of the roller 10 and defines first, second and third slots 32, 33 and 34 respectively which are spaced apart longitudinally with respect to the roller as shown in Figure 7.

As seen in Figure 4, the first slot 32 is defined between first and second longitudinal edges 35 and 36 respectively extending parallel to the roller 10, the first edge 35 being nearest to the screen 3. A lip 37 extends vertically upwardly from the first edge 35 to a height of 4mm above the dividing wall 6. The second and third slots 33 and 34 are provided with corresponding lips.

A filter 38 partially overlays the first slot 32

and has a leading edge 39 which is spaced 0.5mm from the first edge 35 of the first slot 32 so as to leave a gap therebetween. The filter 38 extends continuously between the leading edge 39 and the second edge 36 and is in the form of a clear red transparency which does not introduce appreciable scattering to the light which it transmits.

The total width of the first slot 32 in a direction transverse to the roller is 1mm and is located such that the distance between the first edge 35 and the translucent screen 3 is 35mm.

Beneath the first, second and third slots 32, 33 and 35 are located first, second and third light sources 7, 16 and 40 respectively and each comprising an incandescent lamp having a clear non-scattering envelope. In this example the lamps are Osram Xenophot HLX having a 12 volt 50 watt rating and operated at a running voltage of 8 volts from a direct current source.

Each of the light sources 7, 16 and 40 has a light emitting element in the form of a helical filament as illustrated in Figure 5 in axial view, the helical filament 41 being 3mm in longitudinal length relative to the roller 10 and having horizontal and vertical dimensions of 1mm and 0.5mm respectively.

Each of the light sources 7, 16 and 40 is located a distance of 10mm beneath the dividing wall 6.

The roller 10 is covered with a crumpled foil reflecting surface (not shown) and extends longitudinally 230mm, the corresponding longitudinal extent of the screen being 260mm. The screen has a height of 255mm.

The value of W as measured in horizontal aspect is approximately equal to the filament length (3mm) divided by the distance between the filament and

reflective surface (35mm). The value of V_{min} is about 37.5mm for an image formed 25mm above the dividing wall so that W x V = 3.2mm.

A partially formed image of the filament formed on the screen at this position would therefore be expected to have a width of approximately 3.2mm. Images of such size are comfortably viewable in the context of a domestic heating appliance and provide realistic emulation of flames.

The screen size upon which such images are formed is in this instance the full width of the screen so that D = 260mm which satisfies the relationship referred to above i.e.

$$d > W \times V_{min} \times 50$$

The screen width is therefore sufficient to accommodate about 81 images (260 ÷ 3.2) side-by-side without impairing overall contrast. The crinkling of the reflective surface is arranged to provide sufficient concavities to focus a similar number of images but distributed over the screen in both vertical and horizontal directions to create a full but unsaturated visual effect.

The apparatus described above may be modified to vary the apparent size of the light source by moving the light source towards or away from the slit 32. Alternatively it may be desirable to reduce the apparent size of the light source by interposing a mask having a small aperture which is smaller than the size of the incandescent filament or other light emitting element. Such a mask should be located close to the source.

Apparatus in accordance with the present invention may be modified to include multiple cylindrical rollers to produce more complex flame effects. An additional roller may for example be

rotatably mounted between the roller 10 and the screen 3 so as to be at a slightly lower level. Light reflected downwardly from the first roller 10 may then be upwardly deflected by the second roller on to the screen 3 to produce additional flame effects.

The one or more additional rollers may be rotated at different speeds to the first roller 10.

The reflective surface 14 of roller 10 may be formed by applying a reflective coating to a contoured surface of the roller which may for example be formed by a moulding operation.

The roller may be rotated by means of an electric motor having a reduction gear box or by a drive mechanism including a belt drive. Alternatively convention air currents from the light source 7 and 16 may be utilised by a rotating vane arrangement and suitable drive linkage.

An infra-red lamp may be incorporated in the apparatus and may for example be situated in front of the screen 3 and arranged to reflect infra-red radiation towards an observer by reflection from the screen. The screen may conveniently be angled forwardly so as to deflect the radiation in a generally horizontal direction.

Alternative light sources may be utilised in the apparatus. It is important however that the light source should approximate to a point source rather than being an extended light source in order to ensure sharply focussed striations.

CLAIMS:

1. Apparatus for simulating the visual effect of flames comprising a roller having an irregular reflective surface, a light source arranged to direct light on to a selected portion of the reflective surface such that the light source subtends an angular size W as viewed from the reflective surface, movement means operable to rotate the roller so as to continuously vary the selected portion of the reflective surface on to which light is directed, and a display screen on to which partially formed images of the source are projected from the selected portion of the reflective surface whereby a continuously variable visual effect is displayed on the screen, the visual effect comprising images formed on to respective portions of the screen at respective projection distances V from the reflective surface and wherein the values of W and V are such that, for at least a substantial proportion of the portions of the screen, respective images formed thereon comprise catacaustic fine detail which in the visual effect is suggestive of filaments of flame.

2. Apparatus as claimed in claim 1 wherein the value of W in radians is selected such that images are produced for which the value of W x V lies in the range 0.001 to 0.005 metres.

3. Apparatus as claimed in any of claims 1 and 2 wherein the width d of the screen upon which images are formed satisfies the relationship

$$d > W \times V_{min} \times 50$$

where V_{min} is the minimum projection distance between the reflective surface and the screen.

4. Apparatus as claimed in any of claims 1 to 3 wherein the reflective surface comprises a crumpled layer of reflective foil extending circumferentially around the roller.

5. Apparatus as claimed in any preceding claim wherein the roller is mounted in an enclosure of which the display screen constitutes a front wall, the enclosure having a dividing wall which divides the enclosure into an upper compartment containing the roller and a lower compartment containing the light source, the dividing wall defining a slot through which light is directed on to the selected portion of the reflective surface and wherein the relative positons of the slot, the light source and the roller are such that direct illumination of the screen from the light source is masked by the dividing wall.

6. Apparatus as claimed in claim 5 wherein a coloured filter is located intermediate the light source and the reflective element.

7. Apparatus as claimed in claim 6 wherein the filter is located immediately adjacent the slot.

8. Apparatus as claimed in claim 7 wherein the roller is horizontally mounted adjacent a bottom edge of the screen, the light source being located such that its vertical position is below the rotational axis of the roller and its horizontal position is intermediate the rotational axis and the screen, and the direction of rotation of the roller being such that the selected portion upon which light is directed is upwardly moving.

9. Apparatus as claimed in claim 8 wherein the filter overlays a portion of the slot such that images formed in lower regions of the screen are predominantly constituted by filtered light which is reflected from the reflecting surface after passing through the filter and images formed in upper regions of the screen are predominantly constituted by unfiltered light.

10. Apparatus as claimed in claim 9 wherein the light source emits white light and the filter is a clear red transparency.

11. Apparatus as claimed in any of claims 5 to 10 wherein the slot comprises first and second edges extending parallel to the roller, the first and second edges being respectively proximally and distally positioned relative to the screen, and wherein a lip projects from the dividing wall at or adjacent the first edge so as to mask the slot from the screen.

12. Apparatus as claimed in any preceding claim wherein the source comprises an incandescent filament.

13. Apparatus as claimed in claim 12 wherein the filament extends helically about a linear axis extending parallel to the roller.

14. Apparatus as claimed in any of claims 10 to 12 wherein the value of W is determined by the dimensions of the filament as viewed from the reflective surface.

15. Apparatus as claimed in any of claims 10

to 12 comprising a mask defining a source-limiting aperture of smaller dimensions than the filament when viewed from the reflecting surface, the mask being located in proximity with the source to determine the value of W.

16. Apparatus as claimed in any preceding claim wherein the light source comprises a tungsten halogen lamp.

17. Apparatus as claimed in any preceding claim wherein a plurality of light sources are provided at locations spaced apart longitudinally with respect to the roller to provide visual effects on respective areas of the screen.

18. Apparatus as claimed in any preceding claim wherein the display screen comprises a first translucent plate through which the visual effect is viewable by diffuse transmission of light from the reflective element.

19. Apparatus as claimed in any preceding claim wherein the display screen comprises a first translucent plate having a light scattering surface upon which light from the reflective surface is incident and a second surface which is partially reflecting, the screen further comprising a second transparent plate having at least one partially reflecting surface maintained in parallel spaced relationship relative to the first plate whereby multiple images of the visual effect are created by multiple reflections between the partially reflecting surfaces.

20. Apparatus as claimed in any preceding claim comprising at least one further roller having a respective further reflective surface and being located intermediate the roller and the display screen whereby some of the light reflected from the reflective surface of the roller is projected on to the display screen indirectly by reflection from the further roller or rollers.

21. Apparatus as claimed in any preceding claim wherein the roller is located adjacent one edge of the screen and is uniformly rotated in a direction selected such that an image formed at an initial position on the screen by reflection from the reflective element is moved progressively towards a new position on the screen which is at a greater projection distance from the reflective element than that of the initial position.

22. Apparatus substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

Patents Act 1977
Examiner's report to the Comptroller under S(.ion 17 (The Search Report)

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Relevant Technical fields

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Search Examiner

A N BENNETT

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASES: WPI

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Documents considered relevant following a search in respect of claims 1-21

Category (see over)	Identity of document and relevant passages		Relevant to claim(s)
X	GB 1353021	(UNITED GAS) Whole document	1 at least
X	GB 1223082	(DRUM FIRE) See especially Figure 7	1 at least
X	GB 1113209	(BERRY) See especially Figure 11	1 at least
X	GB 1097812	(BELLING) Whole document	1 at least
X	GB 0450941	(GENERAL ELECTRIC) Whole document	1 at least

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

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